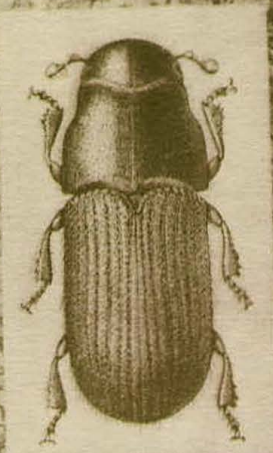


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FOREST INSECT CONDITIONS

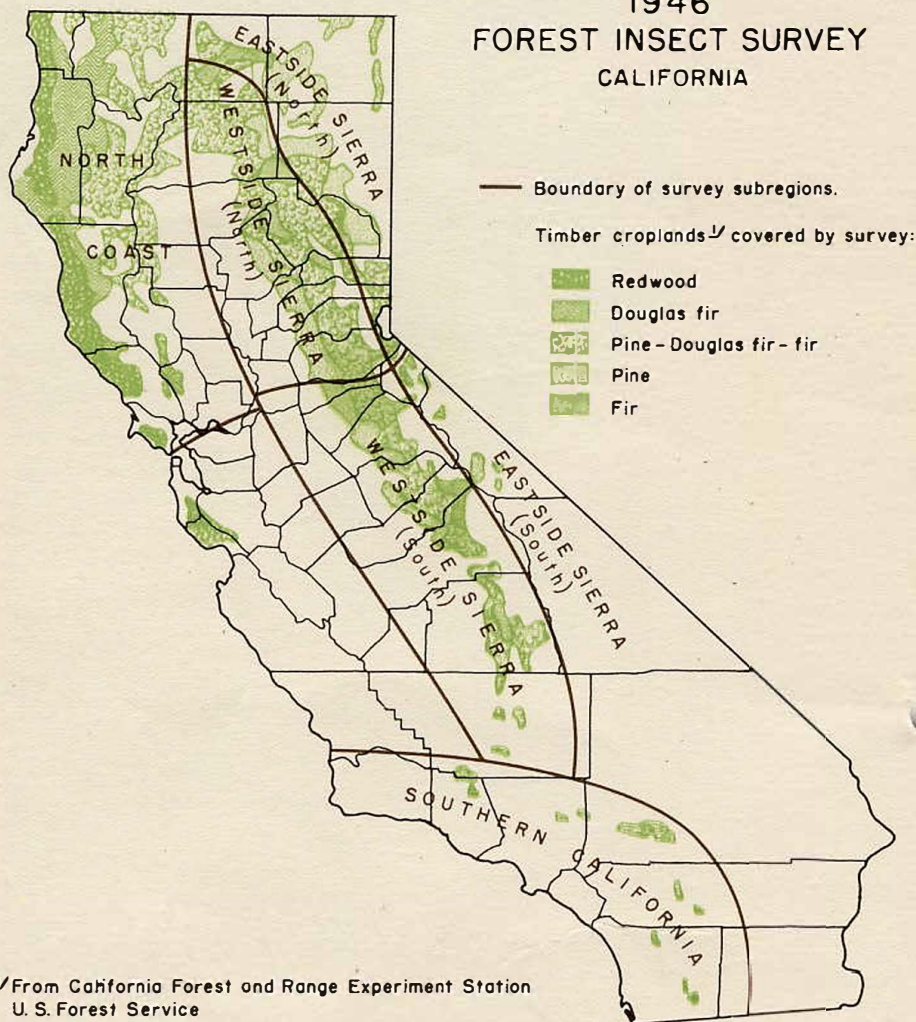
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STATE OF CALIFORNIA
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DIVISION OF FORESTRY
DEWITT NELSON, *State Forester*

Forest Insect Conditions *in* *California During* *1946*

A Report Prepared in Cooperation With the
FOREST INSECT LABORATORY
U. S. BUREAU OF ENTOMOLOGY
AND PLANT QUARANTINE
BERKELEY, CALIFORNIA

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Foreword

Forest insects, particularly bark beetles which attack various species of pines, have been responsible for a heavy loss of timber over the entire State for many years. The total volume of timber killed by insects in the last 20 years approximates 25 percent of the State's lumber production for the same period. Protection of the timber resources from insect depredations is therefore an important phase of the State's forestry program.

Recognizing this forest insect menace, the California State Legislature in 1945 revised the State's Pine Beetle Control Law so as to give the Division of Forestry greater responsibility in the control of insect infestations on state-owned and private timber lands and to cooperate with the Federal Government in bringing bark beetle outbreaks under control.

To meet this responsibility, knowledge of what forest insects are doing in the State and where infestations might be aggressive becomes the first requirement of a protection program. Accordingly, in the fall of 1946 the Division of Forestry joined with the Forest Insect Laboratory of the U. S. Bureau of Entomology and Plant Quarantine, the U. S. Forest Service and private timber companies in conducting a state-wide forest insect survey which included all the forest areas where timber values were at stake. No special fund was created to finance this survey and it was largely carried out by contributed time of regular personnel from each of the cooperating agencies. The over-all planning, direction of field work, compilation and interpretation of results and recommendations for control action was handled by the Forest Insect Laboratory.

In order that the state-wide picture and other information brought to light by the survey may be available to all interested parties, the California Division of Forestry is publishing the following report. Such a report should be the first step in any forest insect control program for the season of 1947. The information which it presents is of importance to lumbering, recreational and agricultural interests as well as to state and federal forestry agencies. This report for the season of 1946 is the first of its kind to be published for state-wide distribution. If the survey and similar reports can be continued on an annual basis in the future, they will serve as an invaluable year-to-year record of the extent to which insects may be affecting the forest resources of California and show what progress forest protection agencies are making in their control.

DEWITT NELSON,
State Forester

Cover and included photos by
U. S. Bureau of Entomology and Plant Quarantine

Forest Insect Conditions in California During 1946

Introduction

Forest insect infestations in the forest and park areas of California have been a matter of public concern for many years. Owners of private timber lands who have encountered the problem of insect-caused losses in commercial timber, recreationists interested in summer homes and resorts in the mountain areas, and stockmen who have found that insects sometimes compete with stock for the browse on their ranges, have all looked to the public forest protection agencies for aid and guidance in dealing with these insect enemies of forest resources. This public concern with the insects that attack forest and range plants in California has recently taken form in legislation passed by the California State Legislature in 1945 which authorizes the State Board of Forestry to cooperate with private owners in the control of forest pests. The need for such action will undoubtedly become more and more apparent as California's increasing population makes heavier and more intensive demands upon its forest resources.

With these developments has come a need for a comprehensive reporting of current infestations in order to present the state-wide picture and point out the particular areas where action is needed. To a very limited extent this has been provided for in the past by reports on special areas of infestation sent in annually by rangers and supervisors of the federal and state forestry agencies and it is highly desirable that this practice be continued. The Forest Insect Laboratory¹ at Berkeley, California, for a number of years has conducted annual surveys to detect insect infestations in those parts of California where the hazard was considered to be greatest. The reports from these surveys have been concerned mainly with specific areas and their distribution has been limited to the federal, state and private agencies who cooperated in the field work of the surveys. General reports of insect conditions throughout the State were issued by the laboratory in 1931 and 1937, but these were based on partial coverage of the territory and their distribution was relatively limited.

During the season of 1946 an effort was made to conduct a general forest insect survey of all of the more important forest areas of the State, regardless of ownership, as a basis for selecting those areas where control work was needed. This project was brought about through the cooperation of the U. S. Forest Service, the National Park Service, the Indian Service, the California

¹ Maintained by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine.

Division of Forestry, and a number of private timber companies and individuals. The survey was coordinated by and under the general supervision of the Forest Insect Laboratory. This report is designed to bring together the findings of the 1946 forest insect survey and to present the infestation picture throughout the California region as a whole, with such interpretations and recommendations as apply specifically to the protection of commercial timber lands, parks and recreational areas.

How the Conditions Were Appraised

It was obviously impossible to make an intensive acre-by-acre survey of forest insect occurrence covering the 17.1 million acres of timber cropland in the State at a cost that would be warranted by the information obtained. Nor was this procedure necessary for the purpose of determining where forest insects currently were causing abnormal damage or where control work should be applied, for previous studies and observations by forest entomologists had shown in what forest types and under what conditions the greatest hazard from insects might be expected.

The field survey, consequently, was limited to approximately 9.7 million acres of old growth, young growth-old growth and large young growth stands in the pine and mixed pine-Douglas fir-fir forest types. No field work was done in the coast redwood (1.9 million acres), Douglas fir (2.6 million acres) or true fir (1.2 million acres) types which are known to be almost immune to, or perennially free of, damaging insect infestations. Added to this acreage was 1.7 million acres of small young growth stands representing lands now undergoing reforestation where damage from insects is a very minor consideration.

Field work on the 1946 survey consisted mainly of (1) various degrees of ground sampling to obtain factual data of current insect-caused timber mortality in specific areas and to add to long term plot records used in studying infestation trends and mortality rates of different kinds of trees and stands and (2) extensive reconnaissance to secure general estimates of current infestations over broad areas.

Primary reliance was placed upon the general reconnaissance type of survey using spot counts of currently infested trees from along forest roads or from fire lookout stations and other topographic vantage points. Most of the reconnaissance, however, consisted of visual appraisal of infestation conditions made by forest entomologists of the Forest Insect Laboratory staff from hundreds of miles of forest road traverses, plus observations and individual reconnaissance surveys by rangers and technicians of the various forest land managing agencies. Upon two occasions extensive areas were also examined from aircraft.

Intensive ground sampling of some 15,000 acres of sample plots strengthened the basis for the more general estimates. Ground samples employed by

the survey were largely permanent or semi-permanent rectangular or roadside plots varying in size from 40 to 320 acres. On these plots all currently-infested trees over 12 inches d.b.h. were located, examined, marked and recorded. Field crews for the plot sampling were made up, in most cases of forest entomologists from the Forest Insect Laboratory, rangers and technicians of the Division of Forestry, and the U. S. Forest Service and National Park Service and foresters of several lumber companies.

As part of its general research program the Forest Insect Laboratory is studying more efficient ways of conducting forest insect surveys. These include new ground sampling techniques and the possibility of using helicopters for both plot work and general reconnaissance. From the results of these studies it is hoped that the annual forest insect surveys of the State can be conducted on a more intensive basis over wider areas at a substantial decrease in cost per acre.

The More Important Forest Insect Pests

THE BARK BEETLES

There are many native insect pests capable of inflicting various types and degrees of damage to forest trees in California.^{1,2} The survey disclosed that damage in 1946 was the result of the work of relatively few insect species, but that among these were several of primary importance which have been responsible for most of the insect-caused damage to the State's forest resources in recent years.

Approximately 85 percent of the damage during 1946 consisted of the outright killing of about 300,000,000 board feet of coniferous timber by a group of cambium-mining insects known as bark beetles. Those attacking various species of pine are sometimes referred to collectively as "pine beetles." These beetles, belonging to the family Scolytidae, are cylindrical, from 2 to 10 mm. long and dark brown or black in color. Their distinctive habit of attack is responsible for their name. The parent beetles bore through the bark on the trunk of a tree in a radial direction and then turn at right angles to construct a tunnel between the bark and wood in which to lay their eggs. These tunnels, known as "egg galleries," together with the small galleries mined by the growing larvae in some cases, make a peculiar engraved pattern on the inner bark surface. Each bark beetle species has its own characteristic design by means of which it may be identified. It is the girdling action of these galleries on the trunks of the infested trees which causes their immediate death.

¹ Keen, F. P. *Insect Enemies of California Pines and Their Control*. Department of Natural Resources, Division of Forestry, Bull. 71. 1928.

² *Insect Enemies of Western Forests*. United States Department of Agriculture Misc. Public. 273. February, 1938.

The Western Pine Beetle

The western pine beetle (*Dendroctonus brevicomis*), an enemy of ponderosa and Coulter pine, is usually the most destructive of all forest insects in California. In 1946, even though infestations were at a comparatively low level, it is estimated to have killed 200,000,000 board feet of pine timber. In the northern part of the State most of the damage occurred in overmature, weakened or "high risk" trees which are most susceptible to its attacks and which it normally prefers. In a few localities, particularly in the foothill pine belt along the west slope of the Sierras, more aggressive infestations built up during the year around small logging areas and areas containing sizable quantities of timber scorched by fires within the past two years. Aggressive infestations appeared in several Southern California localities apparently without the aid of any of these contributing factors. In a few instances active infestations followed prior top-killing infestations of *Ips* engraver beetles (see below). There are indications from several parts of the State that the low point in the infestation cycle of this insect was reached in 1943 and 1944 and that since then its activity and resultant damage has been on the increase. This trend may be accelerated if the precipitation deficiency now present in the northern part of the State at the time this report is written continues.

Direct control of the western pine beetle is usually carried on by a method in which currently infested trees are felled and the bark containing the beetles is peeled and burned. The beetle population is thus destroyed before it has a chance to infest other trees.

An indirect method of control is extensively used against the western pine beetle in northeastern California. Studies carried out in this subregion by the Forest Insect Laboratory over a period of years have shown that certain types of trees are highly susceptible to beetle attack. Removing these "high risk" trees from the stand before they are attacked, by means of a "sanitation-salvage" cutting, accomplishes two objectives: (1) the high risk trees are logged and milled in a normal manner thus realizing their full utilization value and defraying almost all the cost of the operation and (2) the residual stand (from 70 to 85 percent of the original stand) is "bug-proofed" for an average period of about 10 years. In 1946 all national forest timber sales and some cuttings on privately-owned timberlands in Modoc County and the eastern portions of Siskiyou, Shasta, Lassen and Plumas Counties involved cuttings of this nature.

Ips Engraver Beetles

Causing less state-wide damage than the western pine beetle but more spectacular damage in scattered local areas were the California five-spined engraver beetle (*Ips confusus*) and the Oregon pine engraver beetle (*Ips oregoni*). Infestations of both these insects occur sporadically, coming unannounced, lasting a year or two in most cases and then dying out naturally. The damage inflicted on various species of California pines by *Ips* beetles

consists chiefly of the top-killing of trees over about 16 inches d.b.h. and the complete killing of smaller trees and reproduction. Trees are usually attacked in groups, although top-killed mature and overmature trees may be attacked singly and at widely scattered intervals.

The injury to or killing of immature and second-growth timber and reproduction by *Ips* can become very important on recreational areas where the loss of even single small trees may be a calamity or on commercial timber growing areas where these trees are needed for growing stock. More significant is the fact that the western pine beetle is soon attracted to localities where fresh *Ips* infestations are progressing. Small initial *Ips* outbreaks have often been the forerunner of epidemics of the western pine beetle, of the mountain pine beetle in sugar pine and the Jeffrey pine beetle in Jeffrey pine.

Control operations aimed at breaking up *Ips* outbreaks were carried out near Burney, Shasta County, in 1945 and in the Cobb Mountain area, Lake County, in 1946. Further operations are being conducted currently in the latter area as this report is written. The effectiveness of the fell-peel-burn method in controlling *Ips* infestations has not been too fully demonstrated and further studies are needed on this problem.

The Mountain Pine Beetle

The mountain pine beetle (*Dendroctonus monticolae*) is the most destructive insect enemy of sugar pine in California and annually takes a large toll of this valuable timber species. During 1946, sugar pine mortality from this cause remained in endemic status and was of most concern in recreational areas. The mountain pine beetle either kills single trees by the concerted attack of a single generation of beetles or, in the case of some large overmature trees, by the successive attacks of several generations of beetles working from the top down.

This beetle also attacks and kills lodgepole pine in the higher mountain areas of the State. In the past complete stands of lodgepole pine were wiped out by the beetle at Medicine Lake, Siskiyou County and in the Tenaya-Tuolumne Meadows area of Yosemite National Park. The 1946 damage throughout the State was spotty and of relatively minor importance.

The Jeffrey Pine Beetle

East of the Cascade-Sierra range the Jeffrey pine beetle (*Dendroctonus jeffreyi*) has been responsible for the death of millions of board feet of Jeffrey pine during the past two decades. An aggressive tree killer, it appears to exhibit the same selective traits as the western pine beetle by showing a preference for the less vigorous mature and overmature trees in the stands. This characteristic enables it to be controlled by sanitation-salvage cuttings. Jeffrey pine losses from this beetle have been endemic in Modoc, Lassen and Plumas Counties during the past five years but appear to be on the increase in 1946.

The Douglas Fir Beetle

The Douglas fir beetle (*Dendroctonus pseudotsugae*) has from time to time been responsible for the death of Douglas fir in California. The heaviest losses have usually occurred along the west slope of the Cascade-Sierra range where this tree species grows in mixture with ponderosa pine and sugar pine and white fir. Its attacks in this belt have been localized, starting with the death of a small group of trees and expanding the periphery of the group each year until a sizable acreage of Douglas fir has been killed. In 1946, for the first time in California, recommendations were made to control current infestations of this insect at several points in Plumas, Butte and Tehama Counties.

The Fir Engraver Beetle

Infestations of the fir engraver beetle (*Scolytus ventralis*), a primary pest of white and red fir (*Abies* spp.) in California, were of minor importance in 1946, except in some high Sierra areas where there are some indications of increasing activity. In view of the new interest in these tree species for pulp and paper manufacture in California, losses caused by this beetle will become more significant. In addition to its habit of killing trees outright the beetle causes serious injury to the tops of trees resulting in numerous "spike tops" which pave the way for infections of wood-rotting fungi.

MISCELLANEOUS FOREST INSECT PESTS

Insects other than bark beetles were responsible for minor damage to trees and other forest flora in California during 1946. The more important of these are described in the following paragraphs.

The California Pine Flatheaded Borer

This borer (*Melanophila californica*) attacks and often kills slow-growing ponderosa and Jeffrey pines east of the Cascade-Sierra range. Its attacks are frequently associated with those of the western and Jeffrey pine beetles. While the survey found some evidence of flathead beetle activity in north-eastern California, damage in this and other subregions in the State was slight.

The California Oak Worm

The California oak worm (*Phryganidia californica*) staged one of its periodic outbreaks in the central coast region, mainly in Alameda, Marin, San Mateo, Santa Clara, Santa Cruz and Monterey Counties, during 1946. Appearing in great numbers during the summer and fall the caterpillars stripped thousands of live oaks and some deciduous oaks of their foliage. Numerous requests for information were received from alarmed home owners during the fall. Similar outbreaks of the oak worm have occurred fairly

regularly in the past at intervals of four to seven years, but have soon subsided because of the natural control factors. Although the oaks are often heavily defoliated, very few trees die as a result of oakworm damage alone.

The Ceanothus Leaf Miner

A leaf miner (*Baliosus californicus*) caused heavy damage to certain ranges in the State during the 1946 season. The heaviest infestations found were in Butte, Plumas and Tehama Counties where about 75 percent of the sweet birch (*Ceanothus intergerimus*) was defoliated on some 200,000 acres. It was estimated that the available summer forage on the ranges in this area was reduced about 50 percent by the leaf miner. There is no evidence that this infestation has been building up since 1941. It was found to be quite heavy in 1945 and 1946 showed no sign of abatement.

The Oyster Shell Scale

The oyster shell scale (*Lepidosaphes Ulmi*) has maintained persistent heavy infestations in certain forest areas for a number of years, killing cottonwoods, willows and many other deciduous trees and shrubs. Areas where this insect was found working in 1946 are Hat Creek, Shasta County; McCloud, Siskiyou County; and Lake Tahoe. Natural control factors seem to operate very slowly against this insect, and where they have become thoroughly established, their attacks persist until many of the trees die.

The Pine Reproduction Weevil

This weevil (*Cylindrocopturus eatoni*) which wiped out the planted pines on the Big Springs reforestation area in Lassen County a few years ago, developed several new centers of infestation in 1946. There was an apparent subsidence of the infestation in known centers in 1945, but by the end of the 1946 season the weevil was found to be building up in the Mount Shasta brush field plantings (Siskiyou County), the Burney Springs brush field plantings (Shasta County), and in the nursery and arboretum of the Institute of Forest Genetics at Placerville.

State-wide Conditions in Brief

In general, bark beetle infestations in 1946 were endemic throughout the commercial pine areas of the State but their intensity appeared to be increasing. In the north coast counties several small epidemic centers of infestation have developed, the most important being in the Cobb Mountain resort area south of Clear Lake. In the commercial pine region in the northeastern part of the State timber losses caused by the western pine beetle have increased over 1945, but have not yet developed epidemic conditions in any areas. Along the western slopes of the Sierras, conditions are normal

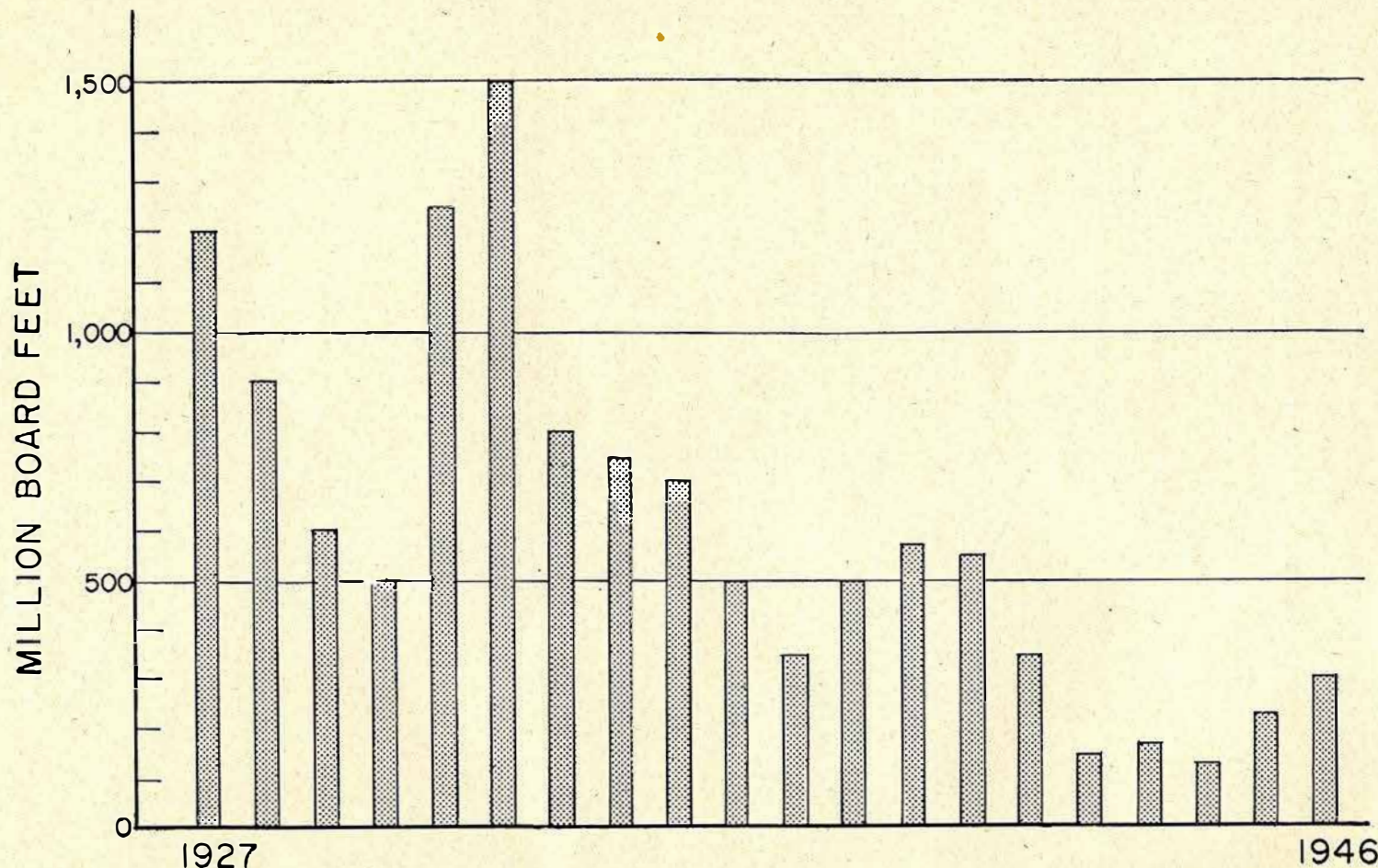


Figure 1. Graphic representation of the amount of pine timber killed annually by bark beetles in California between 1927 and 1946. The total amount of pine timber killed in this period was approximately 13.5 billion board feet. The declining timber mortality in recent years, as indicated by the graph, is attributed to a gradual reduction in the rate of beetle infestation and, to a lesser degree, to the gradual diminishing of the State's virgin pine acreage where most of the infestations occur.

except for heavy post-logging infestations which have developed around the numerous cuttings of small mills. In the second growth pine stands of the lower elevations of the pine belt, these post-logging infestations pose a real problem. In Southern California Ips and western pine beetle infestations have developed to epidemic intensity in San Diego County, and elsewhere there is a marked increase in current infestation trends.

The volume of timber lost because of beetle infestations during 1946 is compared with the estimates for preceding years in Figure 1. This graph is based on broad general estimates of annual board foot volume of pine killed for the period extending back to the year 1937. These general observations and records from sample areas which represent a very small part of the total pine area. There is no measure of their accuracy but they are believed to show the amount and trend of bark beetle infestations during the past 20 years with a fair degree of reliability.

*Conditions by Subregions*¹

The forest insect picture in California will always be a very complicated one because of the great variety of climatic conditions and types that make up the forested areas of this State. The character and intensity of infestations vary greatly throughout the State and can be analyzed to the best advantage if the forest area is divided into subregions based on broad ecological conditions. Forest subregions have been recognized by the California Forest and Range Experiment Station and these have been modified to meet entomological considerations, making a total of six, outlined on the accompanying map (see map inside front cover). In each of these subregions we find that special forest insect infestations have developed and that their behavior and significance is often influenced by local factors. Information relating to the timber stands, forest types and their use can be found in a publication released early in 1946 by the California Forest and Range Experiment Station.²

NORTH COAST SUBREGION

Practically all of the more serious infestations in this subregion have been due to bark beetles attacking species of pine. Douglas fir has escaped severe losses and the redwoods, which are an important type in this subregion, appear to be practically immune to serious insect damage.

In the past there have been heavy Ips and western pine beetle infestations in the Hayfork Valley (1913-16 and 1943-44), in the Eel River drainage north of Clear Lake (1921-23), and the Cobb Mountain resort areas (1937-39).

¹ Subregions shown on map—inside front cover.

² Weislander, A. E., and Herbert A. Jensen. Forest Areas, Timber Volumes and Vegetation Types in California Forest Survey Release No. 4. California Forest and Range Experiment Station, United States Forest Service, Berkeley, California. March 1, 1946. Multilithed.

Conditions by Forest Types

A reconnaissance survey was made of the subregion during October of this year. Bark beetle and other forest insect infestations were found to be at low levels except for a few areas where local outbreaks have occurred.

Ponderosa Pine Stands. The principal damage in virgin stands during 1945 and 1946 was from the western pine beetle. With few exceptions infestations of this insect were decidedly endemic. Quite frequently small groups of vigorous-appearing trees were attacked and killed, but where this occurred the pine beetle had usually attacked in conjunction with the Ips engraver beetle.

While damage from Ips engraver beetle was absent over most of the pine zone, there were several localities where the activity of these insects was quite noticeable. One of these areas was in the Scott River Valley where a large group of pole-sized ponderosa pines was killed in 1945. This group was further expanded in 1946 by additional killings. Several similar groups were seen in the vicinity of Trinity Center on bottomlands of the Trinity River during the surveys of 1945 and 1946. These later groups do not seem to be expanding. A more serious Ips infestation occurred in Lake County which warrants control action.

Jeffrey Pine Stands. On the divide between Castle Creek and the East Fork of the Trinity River in the Shasta National Forest some killing of Jeffrey pine by the Jeffrey pine beetle was noted. As yet, this is not serious enough to warrant control action.

Douglas Fir Stands. Evidence of current damage by the Douglas fir beetle was found along the banks of the Van Duzen River near the Mad River Ranger Station of the newly-created Six Rivers National Forest. These attacks were made upon thrifty mature to mature Douglas firs in groups characteristic of this type of infestation. Most of the groups were newly established in stands where little if any previous damage had occurred. The groups now infested represent a comparatively small percentage of the stand volume but these groups could easily expand, in the next few years, and cause appreciable damage if unchecked.

Ponderosa Pine-Sugar Pine-Douglas Fir Stands. Most of the area in the pine zone of this subregion is occupied by this timber type. The western pine beetle infestation is noticeable but unimportant everywhere in these mixed stands except in the special areas described below. Losses in the Douglas fir portion of the mixed stands can be dismissed since they are practically nonexistent. Losses in sugar pine from attacks by the mountain pine beetle are extremely low.

Areas Requiring Special Attention

Boardman Ridge, Lake County. In 1944 a severe fire 22 miles north of Upper Lake burned through several thousand acres of ponderosa-sugar pine type. By 1946 bark beetles had infested an increasing number of trees apparently scorched or damaged by heat and have apparently spread into adjoining timber. In 1945 and 1946 the attacks of western pine and mountain pine beetles in ponderosa pine and sugar pine respectively are relatively high in vicinity of Nye Cabin, only a few miles across the Eel River from the burn. The aggressive nature of the attacks and the fact that losses here are far in excess of those found in other parts of the Mendocino National Forest indicate that beetle populations emerging from fire injured trees are now attacking in adjacent unburned stands. The potentialities of the Boardman Ridge situation cannot be fully appraised as yet. In the majority of burns in the pine type which have been studied, bark beetle infestations die down within the burn when the supply of susceptible fire-injured trees becomes exhausted and if the infestation does spread to adjoining timber its force does not continue for more than a year or two. The infestations stimulated by fire usually clear up by the third year following.

Lake County Resort Areas. The outbreak of *Ips* engraver beetles in the Cobb Mountain area in the fall of 1945 did not continue in force during the summer of 1946. However when the 1946 survey was made (end of October) there were some indications that *Ips* activity was not entirely over. Some new groups of infested poles and the top killing of some larger trees were found in the area (Figure 2). Activity of the western pine beetle, operating in conjunction with *Ips* attacks in this area, showed an increase. Control work has been recommended for this area and is now in progress. The present infestation and the high values placed on forest cover by summer home and large resort owners warrant maintenance control, probably on an annual basis.

WESTSIDE SIERRA SUBREGION, NORTHERN SECTION

In the ponderosa pine and mixed conifer stands of this subregion, bark beetle infestations in the past have been of a sporadic character. In the pine species the general behavior pattern of these infestations has been characterized by long periods of endemic conditions interrupted by spectacular but short-lived bark beetle outbreaks. Quite often these outbreaks are started off by *Ips* engraver beetles which kill groups of young trees and the tops of mature trees, and are then followed up by western pine and mountain pine beetle infestations which have bred up in the *Ips* top-killed trees. In the northern part of this subregion losses in white and red fir caused by the fir engraver beetle and associated insects have been relatively high in past years.



Figure 2. Group of dying ponderosa pines (indicated by fading crowns) near Anderson Springs, Lake County. This group comprises almost all the trees in the front yard of the summer home pictured at the right. Each of these trees was attacked simultaneously, first by the *Ips* engraver beetle in the tops, then soon after by the western pine beetle in the middle and lower trunk. The killing of trees such as these can be regarded as a major calamity to owners of summer homesites who prize each of their trees highly.

Douglas fir was subjected to severe losses from flathead beetles and from Douglas fir beetle infestations during the period from 1938-44, but at present these infestations have subsided except for local areas.

Conditions by Forest Types

The survey of this subregion was carried out during October on a reconnaissance basis supplemented by small sample plots in areas where infestation conditions appeared to be critical.

Ponderosa Pine Stands. In the northern part of the subregion, bark beetle infestations are still endemic, but with a perceptible increase of the 1946 losses over those of 1945. However, in the central and southern parts of the subregion no evidence of an increase was observed and the losses for 1946 are at an extremely low level. It was noted that the current western pine beetle infestation was found mainly in widely scattered single trees of the large dominant age classes which showed recent lightning injury.

In contrast to the endemic conditions in old virgin stands, in the higher elevations the cut-over reserve and second growth stands at lower elevations contain a number of areas where Ips and western pine beetle infestations are either epidemic or are approaching that condition. Practically all of these epidemic infestations are in areas where numerous small mills are operating or in the vicinity of burns which have occurred during 1944-45. Groups of infested trees were frequently found along recently constructed truck logging roads. It is believed that these outbreaks are due to the attractive influence of fresh cutting, logging injury to standing trees and to the breeding up of bark beetle populations in the slash. Since experience has shown that these infestations usually clear up within two or three seasons, it does not seem worth while to apply direct control measures now, unless there are certain of these areas where owners wish to give their second-growth timber intensive protection.

Pine-Douglas Fir-Fir Stands. Activity of the mountain pine beetle in sugar pine appears to be at a very low level and no serious losses were encountered on the survey. Such losses as were observed occurred as occasional single trees which were usually in advanced stages of decadence and overmaturity. Control work during the spring of 1946 on the Slate Mountain project on the Eldorado National Forest and in the Pinecrest area of the Stanislaus National Forest were effective in reducing infestations in these areas. Jeffrey pine losses are endemic and at the lowest point for several years. Fir engraver beetle infestations in white and red fir are also endemic although some increase in 1946 was noted in small local areas. In Douglas fir the only areas of active infestation of the Douglas fir beetle were encountered in the vicinity of Deer Creek in Tehama County and in the Little Grizzly Creek drainage in Plumas County.

Lodgepole Pine Stands. Evidence of increasing mountain pine beetle activity in this tree species was noted in several widely separated areas at higher elevations. Although these infestations cannot be classed as serious epidemics, the 1946 losses are considerably in excess of those of 1945. The main threat is to values on recreational areas, particularly in the Lake Valley District of the Eldorado National Forest.

Areas Requiring Special Attention

The Kimshe Burn, Butte County. This fire occurred near Stirling City in the fall of 1945 and destroyed about 80,000,000 board feet of timber on 12,000 acres of intermingled holdings of the Diamond Match Company and the United States Forest Service. The lumber company is salvaging much of the fire-killed and injured timber, but this work will not be completed until late next season. A survey of this area in November showed a considerable build-up of the western pine beetle in trees weakened by the fire and not yet salvaged. No loss was observed however on areas adjacent to the burn. No control is recommended for the burned area itself at present, but a careful watch should be maintained in 1947 for possible outbreaks in timber surrounding the burn.

The Quincy Burns, Plumas County. Three fires during the season of 1946 in the vicinity of Quincy destroyed about 50 million board feet of merchantable timber. Salvage operations are being pressed as rapidly as possible by the United States Forest Service in order to remove the beetle-susceptible fire injured trees. As in other similar instances the green stands adjacent to the burns should be closely watched next season for evidence of beetle infestations.

Echo Lake Area, El Dorado County. Increasing mountain pine beetle infestations in the lodgepole pine type have become a threat to this valuable recreational area and if the present trend continues high aesthetic values will be reduced. The present nucleus of infestation is limited to about 80 infested trees and if these are treated before June, 1947, further inroads on the tree cover of the summer home area may be avoided.

WESTSIDE SIERRA SUBREGION, SOUTHERN SECTION

Bark beetle infestations in this subregion follow much the same pattern of sporadic outbreaks as they do in the northern section of the same subregion. During the period 1930-1940, the pine type of this subregion was subjected to a widespread epidemic of bark beetles which subsided after considerable control work was done. The epidemic started with an *Ips* outbreak followed by heavy infestations of the western pine beetle in ponderosa pine and of the mountain pine beetle in sugar pine. Since then bark beetle infestations have been largely endemic except for limited local outbreaks. In the fir types fir

engraver beetle infestations have caused tremendous losses in past years, but have been a minor factor since 1937. In past years the lodgepole pine type in the high elevations has been subjected to epidemics of the lodgepole pine needle-miner, (*Recurvaria milleri*) and the mountain pine beetle which have resulted in "ghost forests" such as those in the upper Tuolumne River watershed in Yosemite National Park.

Conditions by Forest Types

The survey of this subregion was conducted during October. All of the principal commercial timber zones were covered as well as the principal forested areas of Yosemite and Sequoia-Kings Canyon National Parks. No attempt was made to cover high back country with the exception of Chagoopa Plateau in the Kern River drainage of the last named national park.

Ponderosa Pine Stands. The current losses in the lower elevation of this pine type are due to Ips and western pine beetle infestations. As in the northern section of the subregion, the heaviest centers of infestation were found in the vicinity of small sawmills which were operating mainly in second growth stands. The conditions resulting from logging activities were believed to be largely responsible for heavy attacks on groups of standing trees. The heaviest of these infestations were found near Jerseydale, Mariposa County.

Pine-Douglas Fir-Fir Stands. In the virgin pine areas throughout the subregion the general bark beetle situation can be considered as endemic, with the exception of a few localized disturbances. The greatest concentrations found were in the Kings River drainage, near Oak Flat and Patterson Mountain on the Sierra National Forest, and around the General Grant Grove of the Sequoia-Kings Canyon National Park. The heaviest killing was due to the mountain pine beetle in sugar pine by infestations that are believed to have originated by breeding in fire-injured trees in the Black Rock and Goat Corral burns of 1945. In the Kaweah and Kern River drainages in the southern part of this subregion infestations in the mixed conifer type are negligible with infested trees extremely scarce.

Fir Stands. No aggressive infestations were noted in any part of the subregion, although occasional scattered trees were found which had been killed by the combined action of fir engraver beetle and the Sierra fir borer. Considerable limb killing by the former was noted in some of the older growth stands of red fir, particularly in Yosemite National Park at an elevation of 7,000 feet and at the same elevations in the Sequoia-Kings Canyon National Park and the Sequoia National Forest.

Lodgepole Pine-Jeffrey Pine Stands. The killing of lodgepole pine by the mountain pine beetle this year remained at about the same endemic level as in 1945. Localized small group killings were found in practically all of the lodgepole area, particularly in the older stands, but no evidence of any

tendency toward widespread dispersal of these groups. The Jeffrey pine beetle is killing a few widely scattered Jeffrey pines but the volume of damage is not significant.

Areas Requiring Special Attention

General Grant Grove, Fresno and Tulare Counties. An area of approximately 2,500 acres in the General Grant Grove and adjacent national forest lands is involved in a mountain pine beetle infestation which became aggressive during the 1946 season. Practically all of the infested trees are sugar pines of large diameters containing overwintering broods. Control work is recommended for the late winter and spring of 1947 to prevent these broods from escaping to start further attacks during the 1947 season. In the General Grant Grove of big trees is a remnant of the magnificent virgin stands of sugar pine which once covered the western slopes of the Sierra. Protection of this veteran stand from the ravages of insects becomes more important each year if it is to be kept intact.

Fence Meadow, Fresno County. Infestations in mixed conifer stands in the vicinity of Fence Meadow and Oak Flat, approximately 10 miles southeast of Shaver Lake, have shown aggressive tendencies, particularly so in ponderosa pine where groups of trees were killed by the western pine beetle during the summer and fall of 1946. The condition, however, can still be classed as endemic, while, for this reason, control work has not been recommended, the area should be closely checked next year for evidence of epidemic tendencies.

Intensively Used Recreational Areas. This subregion contains a very large acreage of national and state parks, national forest camp grounds and special use areas all of which are subjected to intensive public use. For most of these areas a continuing program of maintenance bark beetle control is desirable to hold infestations to a minimum. The practice of treating infested ponderosa and sugar pines in Yosemite National Park has been followed for a number of years and has proven to be good protective insurance against undue losses. Areas which should be given special attention during the winter and spring are the Wawona road screen and Mariposa Grove in Yosemite National Park and Cedar Grove area in Sequoia-Kings Canyon National Park.

Jerseydale Area, Mariposa County. Infestations attributed to the influence of logging operations are aggressive on about 3,000 acres of privately owned lands. Control work in this area does not appear to be advisable as long as the disturbance created by continuing logging operations persists. The chief danger from this situation appears to be the possibility of the infestation spreading from the logging slash area to surrounding uncut timber.

EASTSIDE SIERRA SUBREGION, NORTHERN SECTION

This subregion of approximately 2,500,000 acres contains vast commercial stands of relatively pure ponderosa pine and Jeffrey pine which have been the site of the most severe and widespread bark beetle epidemics in the California region (Figure 3). The insects that have caused these tremendous timber losses are the California pine flathead, which works in slow growing trees and hastens their deterioration, the western pine beetle which ultimately kills ponderosa pines and shows a preference for trees weakened by the flathead, and occasional outbreaks of Ips engraver beetles which kill tops of large trees and often entire groups of pole-sized trees. The bulk of the losses have been attributed to western pine beetle except in Jeffrey pine where the killing is caused by the flathead beetle and the Jeffrey pine beetle.

Conditions by Forest Types

The 1946 survey of this subregion was made by representatives of the Forest Insect Laboratory aided at various stages by personnel furnished by state, federal and private agencies. Loss estimates were based upon a large series of sample plots augmented by general reconnaissance. In addition, the pine areas of Modoc County were covered by an air survey in a plane furnished by the Forest Service in order to spot any centers of infestation which may have been missed in the ground survey.

The general bark beetle infestations in the subregion showed a decided increase over those of 1945, but no areas were found where these increasing infestations can be said to have reached the critical epidemic stage.

Ponderosa Pine Stands. The current losses in this tree species, caused primarily by attacks of the western pine beetle, are nearly double those sustained in 1945. This upward trend in current loss is particularly noticeable in eastern Lassen County, near the town of Burney, in portions of the Big Valley Mountains and in the area surrounding the headwaters of the McCloud River drainage. There were no epidemic centers of infestation noted, although with the current trend upward, a close check should be maintained to detect possible epidemics in these areas during succeeding seasons.

Jeffrey Pine Stands. The Jeffrey beetle, which is the primary insect responsible for killing this tree species, has shown very low current activity in the northern and southern limits of the subregion but active and aggressive attacks were noted in the remaining area. Throughout eastern Lassen County the current increase in loss attributable to this insect has doubled over conditions encountered in 1945.



Figure 3. Unchecked bark beetle epidemics can raise havoc in merchantable pine forests. Approximately 23 percent of this virgin pine stand in Modoc County was killed by bark beetles between 1925 and 1940. Heavy killings such as these not only reduce the harvest value of the stands, but seriously interfere with inventory growth and mortality calculations needed to keep the stands on a sustained yield basis.

Areas Requiring Special Attention

Eastern Lassen Area, Lassen County. Two separate localities in this area where current losses were of an aggressive nature. To the southeast of Eagle Lake a current flare-up of Ips beetle activity followed in the wake of recent logging operations. These beetles apparently have bred up populations in the slash left by logging and, upon emerging from the slash, attacked standing green trees. It was noted that broods of the summer generations were predominant in the killed trees and it is believed that their aggressiveness in attacking green standing timber has ended. No action in controlling this infestation is warranted at this time.

A considerable number of currently infested ponderosa and Jeffrey pines were noted along the Dixie Valley access road. It was believed that most of these resulted from slash burning injury during the right-of-way clearing. The infestation is expected to be short-lived, but since the area is one of extremely high beetle hazard it will bear watching in order to detect any increased beetle activity which would require control action.

Adin Area, Modoc County. During 1938 and 1939, a light utilization cutting was made in the Roney Flat Unit north of the town of Adin. Since that time, beetle-caused losses in the heavy residual stand have persisted at above normal rates. The reason for an exceptionally high annual loss rate in this cut-over area is not apparent at present. However, it is felt that the pine beetles have maintained themselves in numbers throughout the area since cutting by attacking and breeding in sub-marginal trees of high risk which were left uncut during logging. These beetle populations, together with other unapparent factors contributing to the recurring losses, have helped to foster further beetle activity. Tentative plans have been made by the United States Forest Service to recut this area on a light cutting basis and remove all highly susceptible trees as a measure of control. No direct control action is contemplated.

Siskiyou County. Near the headwaters of the McCloud River drainage where eastside conditions approach those of the Westside Sierra subregion, particularly in the areas near Porcupine Butte, Harris Mountain, Trout Creek, and McCloud Flats, it was noted that current losses are markedly above those sustained in 1945. There is no justification for control action in these areas at present, but the aggressive nature of the attacks by the western pine beetle indicate approaching epidemic loss. These areas should be watched closely for signs of further increased pine beetle activity and control initiated should such conditions develop.

The Burney Area, Shasta County. During 1945 a program of control was undertaken in the Burney and Hat Creek Basins to combat an epidemic

infestation of bark beetles which had developed from slashings left by scattered logging in the area. The control work of that year was very successful in reducing loss caused by certain of the tree-killing species. However, because of a scattering of western pine beetle infestations which persisted in the area, control was again undertaken in 1946 in an attempt to further reduce the amount of loss. Despite these control efforts, current losses in the area are continuing at above normal rates.

An appraisal of the control measures against the 1945 infestation has shown varying results. On the area treated by direct fell-peel-burn methods, current losses are slightly higher than on the untreated virgin areas. Where green high risk trees were removed and milled in "sanitation-salvage" cuttings as an indirect method of combating infestations, current loss is but one-third as great as on surrounding virgin stands. Very little additional benefits were obtained by supplementing fell-peel-burn methods to the sanitation-salvage procedures. In view of the current high loss in the Burney area and the benefits derived from the indirect control measures, it is recommended that sanitation-salvage operations be continued as a means of control in the area.

EASTSIDE SIERRA SUBREGION, SOUTHERN SECTION

The timbered areas of this subregion are widely scattered and occur on such limited sites that the insect problems affecting them are largely of local significance and of minor importance in comparison with other forested regions of California. In the past, however, there have been some fairly serious losses. During a period from 1923 to 1925 there was a severe infestation of the Jeffrey pine beetle following a devastating blowdown of Jeffrey pine in the areas east and north of Mammoth. Again from 1934 to 1937 a widespread insect epidemic, this time by Osler's tussock moth (*Hemerocampa oslari*) visited the area's white fir stands. This was followed by increased activity of the fir engraver beetle causing heavy loss of fir in the Bridgeport and Mammoth areas. Grazing values, too, have been adversely affected at times by recurring outbreaks of insects, mostly by the Great Basin tent caterpillar (*Malacosoma fragilis*) feeding on bitterbrush and other browse plants. A number of recreational areas have also suffered from mountain pine beetle infestations in lodgepole and white pine.

Conditions Found in 1946

A reconnaissance survey of the more important areas was made during the last week of September, 1946. Current infestations were found to be of a low endemic character with no losses of importance. It was not considered necessary to recommend control work in any area, but several areas were noted in which conditions were considered favorable for potential insect outbreaks and these should be closely checked for trends next year.

Areas Requiring Special Attention

Mammoth Lakes Area, Mono County. There is a persistent but minor infestation of the mountain pine beetle in the lodgepole pine stands around the recreational areas. Some effort should be made to prevent further loss of trees on these intensively-used sites.

Mono Craters and Bald Mountain Areas, Mono County. These areas contain the best commercial Jeffrey pine stands in the subregion. Infestation conditions found in 1946 indicate that there may be an early trend toward increasing Jeffrey pine beetle populations and subsequent losses.

Crestview Burn of 1946, Mono County. The type of fire injury in this burn will in all probability contribute to a build-up of bark beetle infestations. During the survey in the fall of 1946 it was too early to make an appraisal of insect losses around this burn, or to determine the amount of concentration of beetles on and around the burn area.

SOUTHERN CALIFORNIA SUBREGION

The timbered areas of this part of California, while not extensive, are of great value from the standpoint of recreational use. Probably nowhere else in the State are individual trees and small groves so highly prized. Protection from insects, therefore assumes an importance far above normal commercial timber values.

In the past bark beetle infestations have caused spectacular losses of trees in a number of these intensively used areas. From 1922 to 1924 and again during 1939 and 1940 the Lake Arrowhead and Crestline resort areas in San Bernardino County were hard hit by Ips and western pine beetle epidemics working in ponderosa and Coulter pines. In 1934 and 1935 the Idyllwild-San Jacinto areas in Riverside County suffered heavy losses from western pine beetle and flathead infestations. Between 1930 and 1935 the Coulter pine stands around Julian and Dyche Valley were heavily depleted by Ips-western pine beetle epidemics. Jeffrey pine in the Cuyamaca and Lagunas areas of San Diego County have been subjected to persistent infestations of the pine flathead and Ips beetles.

In nearly all of the above situations public agencies have brought pressure to bear for prompt control action and the infestations were successfully controlled. The importance of the problem was so emphasized by these past outbreaks that for the past 10 years the areas have been closely watched for outbreaks and a program of annual maintenance control has been carried out on a number of areas.

Conditions Found in 1946

During the past year several examinations were made of the more important forested areas in this subregion by the Forest Insect Laboratory.

In addition, district rangers of the United States Forest Service have supplied information of value in their reports of forest insect conditions in their districts.

In general, damage from bark beetle infestations increased in most areas in the subregion during 1946. The most striking example of this was found around Corte Madera in San Diego County where large groups of Coulter pine trees were killed by Ips beetles and the western pine beetle working together. Losses in Jeffrey pine by flathead beetles was also more prevalent. Most of the heavier damage occurred on the Cleveland and San Bernardino National Forests in San Diego, Riverside and San Bernardino Counties. Damage on the Angeles and Los Padres National Forests in Los Angeles, Ventura and Santa Barbara Counties was not investigated, but it is believed to be slight.

Areas Requiring Special Attention

Corte Madera, San Diego County. Infestations of Ips beetles and the western pine beetle increased rapidly in Coulter pine stands on private lands and adjoining lands of the Cleveland National Forest—this despite some experimental control work and salvage logging carried out during the summer season. Further control work has been recommended for this winter when the results should be more beneficial.

Cuyamaca-Julian, San Diego County. An aggressive Ips-western pine beetle infestation also developed during the year in these areas resulting in heavy losses of young Coulter pine timber. Practically all of the timberlands involved are privately owned. In some cases, as on agricultural lands, the timber is of little value to the owner and the insect infestation is considered more of a blessing than a curse. Around resort areas such as Pine Hills and Whispering Pines, however, the timber has considerable aesthetic value. Due to the various objectives in this general locality a policy of insect control poses a difficult problem which the State Board of Forestry has considered important enough to take steps to find a proper solution.

Other Mountain Resort Areas. These areas—Mount Laguna, San Diego County; Idyllwild, Riverside County; Big Bear Lake and Lake Arrowhead, San Bernardino County—all report slight infestation of flathead beetles in Jeffrey pine or of the western pine beetle in Coulter pine. While none of these is serious at the moment a policy of annual maintenance control is being carried out to minimize the insect damage in these heavily-used recreational areas. The work is being carried out by the United States Forest Service with financial assistance from local flood control districts.

Insect Control Projects Completed

During the winter months of 1945-46 and the following spring a number of bark beetle control operations were carried out by agencies cooperating with the California State Division of Forestry. In general, this work was handicapped by lack of available manpower and extremely high costs were encountered because of the high wage scales for workers and the high prices of the equipment and materials used.

NAPA AND LAKE COUNTIES RESORT AREA

Some 50,000 acres of pine type intermingled with woodland species in these counties is valued highly as tree cover by numerous summer home and resort owners. Once before, between 1937 and 1940, an *Ips*-western pine beetle infestation developed in the Cobb Mountain area and was brought under control by an organized effort on the part of the owners themselves with the aid of a Civilian Conservation Corps camp at Middletown. This protection work was successful but it was discontinued during the war years because of the very light infestations and the scarcity of labor.

A reconnaissance of the area by Division of Forestry personnel in January, 1946, revealed that the beetles were again on the increase (Fig. 4). It was estimated that there were from 2,000 to 2,500 infested ponderosa pines in the area. The killing of pole-sized trees and the top-killing of larger trees by *Ips* beetles dominated the infestation. The situation was further complicated when the western pine beetle population increased by breeding up in the green bases of the top-killed trees. The greater part of the infestation was concentrated in the Cobb Mountain area.

In February, 1946, the State Board of Forestry authorized the establishment of a zone of infestation to include most of the pine type of these counties, and measures were immediately begun by the Division of Forestry to enlist the many property owners in a cooperative insect control program. Most of the agreements with these owners provided that the division would spot and fall the infested trees leaving it to the owner to treat the infested bark, either by burning or by disposal of the infested material through salvage. Control work was carried on by a Division of Forestry crew until April when emerging beetles made further work ineffectual. The work accomplished is summarized as follows:

Trees treated:

Poles under 10 inches D.B.H.	182
Trees, 10 inches to 20 inches D.B.H.	319
Trees over 20 inches D.B.H.	223
Total	724



Figure 4. A group of pole-sized pines infested with California five-spined engraver beetles, *Ips confusus*. The trees were felled for treatment in the 1947 spring insect control project in Lake County.

Due to labor difficulties and the short control season, it was impossible to cover the entire area or for the owners to treat all of the overwintering infestation in the felled trees. The survey in November, 1946, found that, although the infestation had been appreciably reduced, enough active centers remained to require follow-up work during the winter of 1946-47.

BURNEY, SIIASTA AND LASSEN COUNTIES

Success of the large-scale 1944-45 control operations against Ips-western pine beetle infestations eliminated serious epidemic infestations in this area so that the fall of 1945 found the area quite clean except for a few small local centers. Only sanitation-salvage control was recommended by the Forest Insect Laboratory. Private timber owners in the project area, particularly the Fruit Growers Supply Company, decided to cover their holdings with sanitation-salvage control and started operations during the winter of 1945. However, only a limited amount of their acreage was covered by this method and the company preferred to carry on the cut-peel-burn in other parts of their holdings as insurance that the beetles would not undo the satisfactory results secured by the work of the previous year. This resulted in a combination of both direct control and sanitation-salvage being applied to about 7,220 acres in the Burney area during 1946 as follows:

<i>Control method used</i>	<i>Acreage treated</i>	<i>Volume treated (board feet)</i>
Cut-peel-burn	8,140	214,320
Sanitation-salvage	2,200	2,644,350
Combination of two above methods	780	714,890
	<hr/> 11,120	<hr/> 3,573,560

It is believed that the control work, aided by a natural decline in the infestation, was responsible for reducing pine losses in 1946 from an average of 82 board feet per acre in 1945 to 51 board feet per acre in the cut-peel-burn treated area, 20 board feet per acre in the sanitation-salvage treated area and to 17 board feet per acre in the area treated by the combined methods.

SLATE MOUNTAIN, ELDORADO COUNTY

Control work was recommended by the Forest Insect Laboratory in 1945 on an area of about 7,000 acres near Slate Mountain and Pino Grande where bark beetles were becoming epidemic in ponderosa and sugar pine reserves stands left from recent cuttings. Cooperating on the project were the Michigan-California Lumber Company of Camino, the Beach Box and Lumber Company of Placerville, the United States Forest Service and the Division of Forestry. A total of 231 infested trees were treated with a volume of 200,000 board feet. The 1946 fall survey showed better than a 60 percent reduction in insect-caused losses on the treated area.

PINECREST RECREATIONAL AREA, STANISLAUS COUNTY

In the fall of 1945 bark beetle infestations were showing signs of increase in the sugar and ponderosa pines of this highly developed recreational area and control work was recommended. The work was carried on by the United States Forest Service in the spring of 1946, and 28 trees with a volume of 60,350 board feet were treated. Conditions were found to be improved in the fall of 1946.

YOSEMITE NATIONAL PARK

The National Park Service has followed a program of maintenance bark beetle control in the more intensively used areas of this park for a number of years and a fairly comprehensive clean-up was made in the spring of 1946. All infested ponderosa pines and sugar pines were treated that could be found on the valley floor and along the main highways of the Park from Crane Flat to Wawona. In all about 250 infested trees were treated.

BASS LAKE, MADERA COUNTY

An area of 10,500 acres was involved in a western pine beetle epidemic during the 1945 season as a result of bark beetle infestations coming from recent windfalls. Control work was carried out in the spring of 1946 under cooperative agreements between the United States Forest Service, the Division of Forestry and private owners to protect both commercial ponderosa pine stands and the tree cover for an intensively-used summer home and resort area. A total of 191 trees were treated by the cut-peel-burn method, and 259 more infested trees were salvaged by a local sawmill. The survey in October, 1946, indicated that the seasonal loss for this year was 95 percent less than that for 1945.

BLACK ROCK, FRESNO COUNTY

A severe fire in the north fork of the Kings River drainage during the fall of 1943 burned over 1,800 acres and left thousands of fire injured trees which became a breeding ground for bark beetles. In the fall of 1945 these infestations were attacking trees in adjacent timber stands. Of most concern was the loss in a fine stand of sugar pine west of the burn where the mountain pine beetle was killing many large mature trees. To prevent further spread the United States Forest Service carried on control work during the spring of 1945 on an area of 1,280 acres adjacent to the burn. A total of 92 infested sugar pines were treated with a volume of 496,090 board feet, an average of 5,400 board feet per tree. Costs were among the highest ever recorded for this type of work because of the relative inaccessibility of the area, the large size of the infested trees, the high prevailing cost of labor and the impracticability of salvaging the treated trees. The survey made in October, 1946,

showed a reduction of about 90 percent in losses in the heaviest centers of infestation along the borders of the burn. Some distance from the burn, however, control was less successful, with an apparent reduction of only 43 percent from the 1945 losses.

SAN BERNARDINO FLOOD CONTROL DISTRICT

Since 1940 private home owners in the Crestline and Lake Arrowhead districts have used the flood control organization for financing bark beetle control programs in these watersheds. Infested trees are treated each year regardless of the amount of infestation under a cooperative arrangement between the United States Forest Service and the District. The annual clean-up was made in the spring of 1946 and a small number of infested trees were treated. This maintenance work has been highly successful as no serious outbreaks have occurred since it was started in these two areas.

SAN DIEGO COUNTY

During the summer of 1946 a virulent *Ips*-western pine beetle infestation appeared in several areas, mainly Corte Madera, Julian, and Cuyamaca State Park. This caused considerable alarm on the part of a number of owners, and at Corte Madera control work was started in cooperation with the United States Forest Service. During the summer some trees were effectively treated with oil and DDT, many others were logged out and salvaged. A full clean-up of the area was undertaken during the winter period of 1946-47.

Further Action Recommended

Insect detection surveys, like lookouts in fire control, are the first essential step in giving the forests of the State proper protection from destructive forest insect outbreaks. The survey conducted this year through the combined forces of the United States Bureau of Entomology and Plant Quarantine, the United States Forest Service, the National Park Service, the Office of Indian Affairs, the California Division of Forestry and private timber owners has been a good start towards giving the forests of the State the annual check-up which they need. This survey work should be improved and strengthened through education and training of forestry personnel to recognize the early symptoms of forest insect outbreaks; and through the development of a more comprehensive system of sampling under the expert supervision of forest entomologists. It can be expected that forestry personnel in general should be able to recognize increases in mortality of forest stands from beetle activity, but more intensive studies by forest entomologists are needed to determine what insects are responsible, what epidemic developments may be expected and what steps should be taken to prevent or control these losses.

The California Division of Forestry now has funds at its disposal with which to help private timber owners in the control of forest insects where

such work is needed. It is hoped that adequate federal funds will be made available so that comparable control measures may be applied on federal lands to round out control projects and to provide for the necessary technical supervision of this control work so as to obtain the best possible results. Rarely is forest insect control an individual owner problem, but one calling for united and cooperative effort on the part of all affected timber owners, the State and Federal Government.

Photo—Inside Back Cover

Treating crew peeling felled infested ponderosa pine, western pine beetle (*dendroctonus brevicomis*) control project, Stanislaus National Forest, California

Photo—Back Cover

"Ghost Forest" of lodgepole pine killed in 1900 by mountain pine beetle (*dendroctonus monticolae*) in Tenaya Lake Basin, Yosemite National Park, California



